SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM TECHNIQUES

TECHNOLOGY DESCRIPTION

For many site characterization needs, direct push techniques are favored over conventional drilling activities due to cost, schedule, environmental, or safety issues. The U.S. Department of Energy (DOE) Site Characterization and Analysis Penetrometer System (SCAPS) truck is currently located at the Savannah River Site (SRS) and for the last several years has been used primarily for the evaluation and demonstration of innovative samplers and sensors designed for use with a Cone Penetrometer Truck (CPT). In order to assess the performance of new technologies, especially those that address difficult characterization problems, systematic testing under progressively more challenging conditions is often required. Field-testing is the only way to effectively test the performance of technologies in a variety of hydrogeologic settings and to develop reliable, comparative unit cost and performance data. The purpose of the activities funded currently under this task is to extend the capability of CPT truck-based systems for the direct, *in situ* detection of Dense Non-Aqueous Phase liquids (DNAPLs). During the last several years, multiple sensors have been developed and tested under this task and have been combined into a characterization toolbox. The CPT characterization toolbox provides a relatively robust system for the environmental characterization of contaminants, including DNAPLs, in real time. The technologies are evaluated and implemented at Environmental Restoration Waste sites, and the results are used to address real characterization needs

Cold Wringer tritium sampler being tested to collect tritiated water at SRS.

During FY 2000, the following activities are being emphasized:

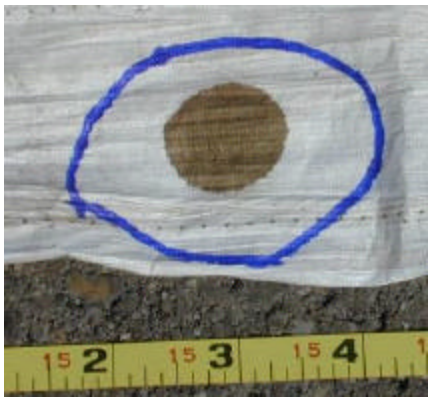
- DNAPL characterization toolbox technologies will be implemented at two DOE waste sites that have significant DNAPL characterization needs, specifically, the Chemical, Metals, and Pesticide Pits at the Savannah River Site (SRS) and the 518 Vapor Treatment Facility at Lawrence Livermore National Laboratory. The DNAPL CPT toolbox currently includes the following technologies: standard sensors for lithologic delineation, Laser-Induced Fluorescence probes, Ribbon Non-Aqueous Phase Liquid (NAPL) Sampler, Field Raman Spectrograph, GeoVis™ Soil Video Imaging System, Science and Engineering Associates, Inc. (SEA) Cone Permeameter™, Geoprobe™ Membrane Interface Probe, and various sediment and groundwater samplers. A subset of the technologies will be used at each site; the combination of information from multiple sensors for a given site will be used to target the site-specific DNAPL characterization problems.

- An innovative method will be developed to determine the concentration of tritium in soil moisture in the vadose zone. The proposed method is to extract soil gas and condense the soil water vapor for tritium analysis. The method will be developed for use with cone-penetrometer based soil gas extraction modules and for monitoring soil vapor from wells.

- Technical assistance is being provided to technology vendors to implement new technologies at SRS. Technical support will be provided to Applied Research Associates to deploy the Wireline Cone Penetrometer system at several SRS waste sites.

TECHNOLOGY NEED

The cone penetrometer is a cost-effective and rapid tool for environmental site characterization in unconsolidated and semi-consolidated soil formations. In its standard configuration, the cone penetrometer is recognized as the most efficient tool for delineating lithology and stratigraphy in sedimentary formations. Currently, many CPT sensors and probes are under development that will extend the capabilities of CPT trucks. These tools will enable the real-time detection and processing of subsurface contamination data during operations. Although many of these sensors can provide better information in a cost- and time-effective manner, they are often not chosen by environmental line organizations due to the limited availability of independent cost and performance data. The activities of this task are focusing on collecting cost and performance data as well as providing technical and engineering assistance in the application of these technologies at DOE sites with real problems.



Typical Dense Non-Aqueous Phase Liquid(DNAPL) Spot on Ribbon NAPL Sampler

During FY 2000, most of the sensors chosen for evaluation under this project target a very high priority DOE need for characterizing and monitoring areas with DNAPL contamination in the subsurface. Residual industrial solvents are currently the most significant challenge for the successful completion of many large groundwater and soil cleanup efforts. Slowly dissolving DNAPLs provide a major source of groundwater contamination for hundreds of years and traditional sampling approaches generally are not successful at locating DNAPLs. Adding to the challenge, DNAPLs are very difficult to characterize in the subsurface--especially when they are found in dispersed blobs as is typical at many sites. The current DOE Site Technology Needs document identifies over 20 waste sites where the characterization of DNAPLs is a priority. The current baseline method for DNAPL characterization involves collecting a large number of sediment cores, a process that is expensive, time-consuming, and has the potential for creating pathways that enhance the downward migration of contaminants. The identification of successful techniques for *in situ* DNAPL characterization will significantly reduce costs and substantially

improve the quality of characterization and monitoring efforts at sites contaminated or potentially contaminated with DNAPLs.

The ability to collect samples of tritium-contaminated water from the unsaturated zone is a problem unique to DOE. Although, suction lysimeters are commonly used for this activity they are limited because they require skilled practitioners for proper installation, and sample collection can take several days to weeks. The tritium sampler developed in the task will simplify the collection of samples from the unsaturated zone.

Applicable Site Technology Coordination Group Need Statements:

- SR99-3021 - Alternative Sample Collection and Well Installation Technology That Eliminates or Significantly Reduces Aqueous or Non-Aqueous Investigation-Derived Waste (IDW)
- OK99-01 - Characterization and Removal of DNAPLs and Light Non-Aqueous Phase Liquids (LNAPLs) from Soil and Groundwater
- RF-ER14 - Characterization/Detection/Verification of Non-Aqueous Phase Liquids (NAPLs)
- Chemical Form and Mobility of Dense, Non-Aqueous Phase Liquids in Hanford Subsurface Transport of Contaminants RL-SS25-S
- ORHY-01a - Dense Non-Aqueous Phase Liquid (DNAPL) Source Characterization, Containment, and Treatment
- ORHY-01b - Dense Non-Aqueous Phase Liquid (DNAPL) Source Characterization, Containment, and Treatment
- ORHY-01 - Dense Non-Aqueous Phase Liquid (DNAPL) Source Characterization, Containment, and Treatment
- SR99-3017 - Dense Non-Aqueous Phase Liquid (DNAPL) Characterization and Remediation Technologies

TECHNOLOGY BENEFITS

The use of the CPT methods for environmental characterization and monitoring is favored over baseline drilling and sampling because in many situations CPT systems:

- Provide continuous, real-time, subsurface information to aid in site characterization operations as they progress.
- Minimize disturbance to the subsurface as no drilling fluids are used and the push-hole diameters are quite small (approximately 1 to 2 inches in diameter).
- Cost considerably less than conventional drilling and sample analysis methods.
- Offer the advantage of real-time data analysis so that the push location can be selected based on the results of holes already pushed.
- Can be used with sensors to measure various types of chemical contaminants and other physical characteristics of the subsurface.
- Is safer than conventional drilling because worker exposure is minimized due to faster subsurface access and the minimal amounts of waste generated.
- Makes possible the rapid and cost-effective definition of contaminant plumes thus enabling more accurate placement of remediation systems and monitoring wells.

TECHNOLOGY CAPABILITIES/LIMITATIONS

When considering the selection of CPT at a particular site, the technology should be compared with the standard drilling and chemical analysis procedures in use at the site. CPT methods will not replace standard sampling and analysis for site characterization and monitoring, but they may provide a way to optimize sample collection and analysis. The use of CPT is dependent on appropriate geologic conditions to ensure penetration to the required depths.

The continuous nature of CPT investigations allows the use of screening technologies, especially contaminant sensors, to measure information on a depth-discrete scale. These technologies provide the most accurate possible information about the precise intervals where contamination occurs, leading to optimized remediation design. The real-time nature of the information allows for better use of characterization and monitoring resources and improves the quality of the characterization. The CPT technologies are limited to unconsolidated sediments and to the maximum depth capability of the CPT truck. The contaminant data are also limited by the lack of regulatory acceptance and are best used to optimize subsequent characterization and remediation.

Currently, a baseline system for the *in situ* detection of DNAPLs does not exist. Combining the information from multiple sensors using a weight-of-evidence approach should provide a robust, real-time system for the direct detection of DNAPLs.

COLLABORATION/TECHNOLOGY TRANSFER

This work is a collaborative effort between various federal agencies, universities, and private industry. Principal partners include: Applied Research Associates, Inc.; FLUTe, Inc., Lawrence Livermore National Laboratory, and Savannah River Site.

ACCOMPLISHMENTS AND ONGOING WORK

FY 1999/2000 Evaluations and Deployments

- Ribbon NAPL Sampler (LLNL, SRS)
- GeoProbe™ Membrane Interface Probe (SRS)
- ARA Wireline System for Cone Penetrometer
- Laser Induced Fluorescence (Pinellas)
- Cold Wringer Tritium Sampler (SRS)
- Raman Spectrograph (SRS)

FY 2000 Innovative Technology Summary Reports

- Sonic Cone Penetrometer

TECHNICAL TASK PLAN/TECHNOLOGY MANAGEMENT SYSTEM INFORMATION

TTP No./Title: SR16C221 - Site Characterization and Analysis Penetrometer System (SCAPS) Logistics and Dense Non-Aqueous Phase Liquid (DNAPL) Characterization
Related TTP No./Title: SR18SS32 - Applied DNAPL Characterization Methods, and SR17C221 - Development and Deployment of Innovative DNAPL Characterization Methods. The investigators on these tasks have collaborated successfully for many years, and many useful technologies have emerged from these leveraged efforts.
Tech ID/Title: 243 - Cone Penetrometer Support: Operation, Maintenance, and R&D Activity Conducted on the OTD Cone Penetrometer Vehicle

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